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## ELEMENTS OF ELECTRICAL ENGINEERING.

*Electrical Engineering in Theory and Practice.* By G. D. Aspinall Parr. Pp. viii+447; illustrated. (London: Macmillan and Co., Ltd., 1906.) Price 12*s.* net.

THIS book is the first of two or more volumes dealing with the subject named in the title. It is introductory, and treats of the elementary theory and testing methods while describing the simpler apparatus used in electrical engineering. Direct and alternating current machinery are to be dealt with in a later volume.

Magnetism is first considered, then electrostatics. Electric currents and electromagnetic effects follow, and in this way the more practical portions of the work are approached. Each chapter ends with a set of examples, chosen, for the most part, from papers set by recognised authorities. The student who works through these examples after reading each chapter will obtain a good grasp of its contents, even though one or two of the examples are perhaps unfortunate, as, for instance, that specially worked out on p. 85, which relates to a rather impossible generator the voltage of which drops noticeably when a high-resistance voltmeter is connected across its brushes. The author has taken considerable trouble to bring the book up to date, both in the descriptions of apparatus and by frequent reference to the more important of recent papers.

There is much, however, in the book, and chiefly in its earlier chapters, which to the present writer seems open to criticism. It professes to be a text-book introductory to the subject of electrical engineering. As such, its functions are surely to show clearly how the various elementary formulæ used by the electrical engineer are derived, and to describe the appliances by which electrical and magnetic quantities are measured, and also the simpler commercial applications. Many books have been written which have had this aim, but few have attained it. Either a theorist writes a text-book which, however perfect theoretically, is so far removed from actual practice as to be almost useless to the engineer, or a book is written like the present, which is full of useful information, but is not sound theoretically; or perhaps one should say rather that it is incomplete on that side. Rigid proof of fundamental formulæ is shirked, and the student loses that confidence in them which always goes with a precise knowledge of the way in which they have been derived. Text-books on electrical engineering at any rate, should not now be written to which either of the foregoing reproaches can be urged, for the day is gone in which it was questioned whether a sound theoretical training was necessarily the basis of a practical engineer's knowledge.

The present work is quite large enough to deal thoroughly with the theory without even increasing the space devoted to this part of the subject; and yet, when reading it, just where one would expect an exact statement of the way in which a given formula has been derived, one reads that "it can be shown," or that "space will not permit a proof here." Such passages occur frequently; for instance, when deriving the magnetic force near a long wire (p. 129) or that in a long solenoid (p. 131); or, again, when obtaining the relation between hysteresis loss and the area of curves of cyclic magnetisation (p. 147), the pull along magnetic lines of force (p. 157), the capacity of a condenser (p. 173) or of condensers in series (p. 180), and the energy stored in an inductive circuit (p. 197). It is true that in one or two of these cases some very elementary application of the calculus would have been required; but even this may surely now be expected of any reader to whom the theoretical portion of the book shall be of any use at all. An equivalent graphical proof may frequently be given with advantage instead of the symbolical one, so that even this difficulty may be met. These comments do not apply to the derivation of the more complicated expressions, but only to the derivation of those which form the basis of other formulæ which the engineer may frequently have to use.

The section entitled "Electrical Resistance" includes, not only an account of the various standard and testing resistances employed, but also much useful information on insulating materials and the forms they take in practice. A matter of importance to electrical engineers is the subject of contact resistance, and particularly that occurring with carbon brushes on commutators. Exact information on this point is now available which should find a place in such text-books as the present. A few pages might also have been devoted to resistances for the absorption of power, and more than a casual reference to the use of micanite as an insulator. Considerable space is devoted to the magnetic qualities of iron stampings. One of the best chapters is that on electrical and magnetic instruments, in which the various types now used in testing and switchboard work are well described. It may be remarked, however that under hot-wire instruments, that of Hartmann and Braun, which is the only such instrument widely used, is not described.

Although the book is generally quite readable, the English is by no means perfect throughout. The reasoning is here and there unsatisfactory, loose language creeps in, or the style becomes diffuse. These are, however, small matters, which will no doubt be remedied in a later edition.

The book includes a large number of excellent tables of physical constants and data useful to the engineer, from which much redundant matter has been excluded and modern information put in its place. Such data should always, in the present writer's opinion, be so stated as to give an idea of the percentage accuracy attainable in their measurement. To quote the hysteresis loss in tungsten steel as 216,864 ergs per cycle (p. 150), or the specific resistance of paraffin wax as $13{,}385 \times 10^6$ megohms per inch cube (p. 107), is to give a false impression of the useful accuracy attainable. Three significant

figures in the former and two in the latter would be ample. Indeed, those familiar with insulation resistance measurement will agree that to get results concordant even in the exponent of 10, let alone the significant figures, is not always easy with such material as paraffin wax, and a much greater accuracy in stating the measurement has, therefore, no meaning.

The illustrations, of which there are nearly 300, are on the whole good, especially those of apparatus. Among the illustrations, however, there are some diagrams, such as Fig. 88, which are singularly poor, chiefly through faulty perspective drawing.

The section on glow-lamps is good and up to date, and includes a very full account of the construction and use of vacuum pumps. The subject of arc-lamps and of illumination is also well treated. The concluding section, on the "production of electromotive force" (induced voltage being, presumably, excluded), contains an account of thermoelectric effects and of primary and secondary cells, the latter being given due prominence, as becomes their importance to the engineer.

The descriptive portion of the work is throughout very carefully written and illustrated. It is full of representative information as to recent types of apparatus. It will thus be seen that Mr. Parr has placed before us a book on the elements of electrical engineering which, if not satisfying from every point of view, is nevertheless a good example of the type of text-book which will introduce the student at once to the theory and to the elementary practice of his subject. D. K. M.

*COLLECTED WORKS OF ERNST ABBE.*

*Gesammelte Abhandlungen.* Zweiter Band. By E. Abbe. Pp. ii+346. (Jena: G. Fischer, 1906.) Price 7.50 marks.

THE first volume of Prof. Abbe's works has already been noticed in the pages of NATURE (vol. lxix., p. 497). The contents of the second volume, while extremely interesting, are more miscellaneous in their character. The editors did well in collecting together in one volume their author's epoch-making papers on the theory of the microscope and his original papers on optical problems.

Abbe's friends, however, will value the possession of his complete writings, and the volume now under review shows the width of his interests and the extent of his knowledge. It opens with his inaugural dissertation at Göttingen in 1861 on the experimental foundation of the law of the equivalence of heat and mechanical energy, a paper which deals chiefly with the thermodynamics of a perfect gas so far as they can be deduced from the first law. This is followed by two astronomical papers of somewhat local interest communicated to the Frankfort Physical Association.

The fourth paper is Abbe's dissertation on receiving authority to teach in the philosophical faculty at Jena in 1863, and is on the law of the distribution of errors in a series of observations.

Abbe's interest in optics was, as is well known, first aroused by the request to help Carl Zeiss in his construction of the microscope, and it is clear that as a young man other branches of science attracted him.

A paper reprinted from the Jena *Zeitschrift für Naturwissenschaft* for 1874 follows, occupying some eighty pages of the volume, and gives his own account of two of his best-known instruments. It is entitled "New Apparatus for the Determination of Refractive Indices and Dispersion Constants," and in it are described the Abbe refractometer and the method of determining refractive indices by total reflection.

The Abbe refractometer is well known, and in the skilful hands of the Jena firm has developed into a most useful and valuable instrument. Abbe's own account of its development and of the reasons which led him to its adoption are full of interest; it was one of his earliest instruments in which the principle of autocollimation was employed; the light from the collimator is made to fall normally on the second face of the prism the index of which is required and to retrace its path; when this is the case the angle of refraction is equal to the angle of the prism, and can be easily measured; the angle of incidence can also be measured, and from a knowledge of the two the refractive index is obtained. The principle which forms the basis of the method described in the second part of the paper has been further developed by Pulfrich in his well-known total refractometer.

Another interesting article is the first list of the productions of the glass technical laboratory of Schott and Company at Jena, dated July, 1886. The story of this work has often been told; the growth of the Jena firm in the twenty years which have elapsed since the first list was published affords conclusive proof of the fertility of the union of the mathematician who had the skill to apply his knowledge in aid of the needs of industry and the manufacturer who realised that Abbe's science had a commercial value, and could be made a factor of real importance in the struggle for progress.

The introduction to this first catalogue of optical glasses opens thus:—

"The industrial undertaking which is here first brought before the notice of the public arose out of a scientific investigation into the dependence of the optical properties of solid amorphous fluxes on their chemical composition which was undertaken by the undersigned with a view to bring to light the chemico-physical foundations of the production of optical glass"—

and though at present there are many problems which confront the glass maker, thanks to the researches of Abbe and Schott the knowledge of 1906 is far in advance of that of 1886.

Enough has perhaps been written to show the interesting character of the book. Among the other papers are accounts of some of the various apparatus designed by Abbe, including the now well-known prism binocular, and some reviews and notices, both of books and men. Of these, perhaps the most noticeable is an address delivered in the hall of the Physical Institute at Jena on March 5, 1887, to commemorate the centenary of the birth of Fraunhofer,